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Abstract

Governments that lack the capacity to mine resources themselves have to attract foreign direct investment. However, since resources are not renewable, countries need to capture a 'fair' share of mineral resource rent to promote their development. While the third raw materials super cycle increased the global turnover of the mining sector by a factor of 4.6 between 2002 and 2010, the tax revenues from the non-renewable natural resource sector earned by African governments only grew by a factor of 1.15. The sharing of mineral resource rent between governments and investors is often criticised for being unfavourable to African governments. But what do we really know about the mineral resource rent sharing in Africa? The aim of this study is to review theoretical and empirical studies on rent sharing in Africa and note their limits for the knowledge of the actual mineral rent sharing.

Key words: Taxation, Mineral Tax, Resource Rent Tax, Developing Countries

JEL codes: H25, L71, L72, L78

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1. Introduction

Over half of African countries produce mineral resources, and 20 of the continent's 54 countries are considered to be natural resource-rich according to IMF criteria[1]. Although it harbours around 30% of all minerals on the planet, Africa is still the continent where the least use is made of mineral resources. Expenditure on exploration has risen significantly over the past decade, however. A record was set in 2012, when African accounted for 17% of the global exploration budget (for all minerals combined), estimated at 23.42 billion USD[2]. It overtook Canada and took second place behind Latin America. While the Democratic Republic of the Congo is the country where exploration expenditure is highest, West Africa has become a priority region for expenditure on searching for gold deposits. The mining sector thus presents a number of issues for the development of countries.

In most cases, natural resources are public property, and the relationships between investors and governments are complex. Governments that lack the capacity to mine resources themselves have to attract foreign direct investment[3], but since resources are not renewable, countries need to capture a 'fair' share of mineral resource rent to aid their development. From the point of view of mining companies, the role of governments is to maintain a stable system that is favourable to business. The characteristics of the sector – namely irreversibility of investment and uncertainty as to whether a project will be profitable (extraction costs, sale price of the mineral extracted, etc.) – make the extraction of natural resources particularly sensitive to economic policy decisions. Decisions on taxation can have consequences that are crucial to the sector's development.

So far, mining taxation systems have adapted to changes in the prices of raw materials. In the 1980s-1990s, commodity prices were low and governments granted companies a large number of tax and non-tax concession for various period of time. The mining sector has been liberalised (Campbell, 2004) and African countries are developing their tax systems to attract foreign investors (Otto, 1998; Land, 2007). Exceptions to general law are becoming a key component of tax framework to reduce the multinationals tax burden and hence to make deposit more profitable. While the third raw materials super cycle increased the global turnover of the mining sector by a factor of 4.6 between 2002 and 2010, the tax revenues from the non-renewable natural resource sector earned by governments only grew by a factor of 1.15[4]. The increase in global prices is overturning the balance of power between investors and governments. In total, 110 nations amended their mining codes recently or are planning to do so (Otto *et al*., 2006 and Appendix 1). The current political context of the sector is strained; governments do not want to

[1] IMF (2012), Sub-Saharan Africa: Sustaining Growth Amid Global Uncertainty, World Economic and Financial Survey, Washington DC.

[2] SNL Metals Economics Group: Worldwide Exploration Trends 2013.

[3] All of the big multinationals in the sector have a presence in Africa: Glencore Xstrata (iron in Mauritania, zinc in Burkina Faso, copper and cobalt in DR Congo, nickel in Tanzania, copper, cobalt and zinc in Zambia, zinc in Namibia, chromium in South Africa, etc.), Rio Tinto (aluminium in Cameroon and Ghana, bauxite in Guinea, ilmenite in Mozambique, copper and ilmenite in South Africa), Anglo American (diamonds in Botswana, Namibia and South Africa, platinum in Zimbabwe, iron and manganese in South Africa), Barrick (copper in Zambia), Newmont (gold in Ghana), AngloGold Ashanti (gold in Ghana, Guinea, Mali, Namibia, DR Congo and South Africa) and Kinross (gold in Ghana and Mauritania).

[4] FERDI tax revenue database (http://www.ferdi.fr/fr/indicateur/base-de-donn%C3%A9es-sur-les-recettes-fiscales-en-afrique-sub-saharienne-1980-2010).

repeat the mistakes made in previous decades, and companies fear 'hold-ups' or expropriations like what occurred in Latin America (Daniel *et al*., 2010; Duncan, 2006).

This political background stresses the issues of mining taxation. The development of taxation systems and tax competition between countries (Land, 2007) are highlighting the lack of a theoretical and/or empirical consensus on the issue of how resource mineral rent should be shared. It now appears to be vital to build a win-win relationship, and hence to find ways of achieving a 'fair' sharing of revenue between governments and investors (Black and Roberts, 2006; Daniel, 2010). The aim of this study is to review theoretical and empirical studies on rent sharing in developing countries. Re-examining the definition of resource rent and the concept of 'fair' sharing between investors and government helps to understand the debates. Reviewing the empirical studies carried out on the subject will then make it possible to identify the existing tools used to analyse resource rent sharing and their weaknesses.

2. Theoretical approaches: definition of rent and optimal taxation

The main criticism of taxation is to cause economic distortions which induce an efficiency and wellbeing lost for society (Sandmo, 1989). In theory, taxing up to 100% of rent would not change investment and extraction decisions. A rent tax seems to be close to a neutral tax. In practice, however, there are many obstacles to apply a "neutral tax instrument" to the sector: geological uncertainties, constraints on production capacity at the global level, etc… Governments, therefore, try to create a tax system to capture a proportion of rent that is deemed to be 'fair' whilst encouraging private investors to explore, develop and exploit minerals. This first section examines the definition of rent and the theoretical foundations that support neutrality in its taxation, and then the tax instruments and other charges and fees burden by the sector.

2.1. Taxation of rent and economic efficiency

The definition of rent that is most widely used today is: 'the excess of revenues over all costs of production, including those of discovery and development, as well as the normal return to capital' (IMF, 2012). Although the definition appears to be straightforward, rent is still difficult to understand.

Ricardo (1817) defines rent in terms of difference of agricultural land fertility. He observes that for the same level of output, the least fertile land requires the greatest amount of labour or capital and that if the price does not cover costs, production occurs at a loss and output is not brought to the market. It is therefore the most productive, i.e. most fertile, land that will yield a larger profit. The rent is a long-term rent which therefore depends on differences in fertility between land and corresponds to the difference between the marginal cost of production and the price. Rent does not play a role in setting the sale price of the resource; rather, it is a result of this price-setting. According to Garnaut and Clunies Ross (1975, 1983), this *'differential rent'* or *'pure rent'* is the defining characteristic of mining industries, i.e. the fact that production conditions, which depend on the characteristics of the exploitation of the resource (location, difficulties in terms of exploitation, quality of the resource, etc.), cannot be identically reproduced. This means that taxing up to 100% of the differential rent generated by the sector should not alter the allocation of resources within the economy, which corresponds to the

From the second half of the nineteenth century onwards, the concept of rent expanded to encompass all advantageous situations which make it possible to increase the revenue of an economic operator (Khan, 2000[5]; Otto and Cordes, 2002; Otto et al. 2006). Economic rent generally stems from private property and limited supply[6]: contracts, patents, barriers to entry into certain markets, and so on. The task of valuing rent is complicated, as long-term rent can differ from short-term rent.

In the short term, production continues for as long as the sale price covers variable costs such as labour and energy (McDonald and Siegel, 1985). If the market price is below the average total cost of production but equal to or greater than the average variable cost, the activity yields a short-term 'rent', also known as '*quasi-rents'.* This quasi-rent corresponds to the difference between the revenue generated by the activity and the variable production costs, i.e. the cost of fixed factors valued at the market price (Otto *et al*., 2006). Quasi-rent can, however, be greater than fixed costs alone when the revenues generated by the activity cover all variable costs and some of the fixed costs.

Mining activity comprises three stages: exploration, development and extraction (Garnaut and Clunies Ross, 1983). During the first two stages (exploration and development), investments are large and constitute fixed costs which cannot be reversed by the investor. At the end of first stage, quasi-rent corresponds to expected revenue less exploration and development costs of the deposit. At the end of the second stage, quasi-rent corresponds to expected revenue less extraction cost. Total rent, which takes into account all costs associated with the various stages of the project and all revenues generated by the project, can be less than the sum of quasi-rents. Therefore, seeking to achieve neutrality of taxation entails seeking to tax, not quasi-rents, but rent valued over the entire lifetime of the project (Boadway and Keen, 2010).

In a dynamic view of rent, Hotelling (1931) introduces the issue of inter-temporal management of non-renewable natural resources. How should one allocate a given quantity of resources between different periods of time so as to maximise the utility derived from the extraction and consumption of the resource? He then defines *scarcity rent*. The extraction of a resource generates a cost of use which corresponds to the opportunity cost of reducing stock for future use (Tilton, 2004). The producer then seeks to maximise the net present value of the project, i.e. revenue less the various costs over time. The investor increases his output until the sale price covers the marginal cost of production and the opportunity cost. Valuing this opportunity cost is therefore of crucial importance, as this determines the taxable rent and alters investment and extraction decisions.

Whilst the aim of the tax system is to capture rent throughout the lifetime of the project, leaving the required minimum return on investment for the investor, inaccurate valuation of the economic rent, and hence the net present value of the project, it inevitably causes economic distortions: over-exploitation or, conversely, under-exploitation of the resource (Guj, 2012). The valuation of rent is subject to a certain number of constraints: knowledge of prices, costs, and the discount rate. This information is difficult to obtain or predict, but absolutely necessary in order to apply an optimal and economically neutral tax.

[5] The author distinguishes between at least six different types of rents.

[6] If the factor of production is public property which is available in an unlimited quantity and accessible to everyone, there is no rent (this applies to the environment, for example).

2.2. Taxation of rent and increase in the number of objectives in developing countries

Taxation of the mining sector is essentially a delicate balancing act between the desire to attract the international investors necessary to tap into mineral resource rent and 'sufficient' capturing of this rent by and for the government (Laporte and Rota-Graziosi, 2015). This balancing act is made particularly delicate by the characteristics of the mining sector (non-renewable resources, irreversible investments, high uncertainty) and international competition to attract foreign technical expertise, which is limited but essential to extract the resource. In practice, the competition between countries means that governments capture about 50% of rent (Land, 2008) and that investment depends not only on the current resource rent sharing system, but also on the anticipated resource rent sharing system (Boadway and Keen, 2010).

Anticipation of taxation during the various stages of a project is crucial for investors. If an investor thinks that the tax system will be unfavourable to him during the production period, there is a risk that he will not make his investment ('hold-up risk'[7]). However, if the tax system is changed after investments are made, the investor no longer has any choice. As long as it covers variable costs, production is economically preferable to stopping production. So as the capital invested by a company increases, the balance of power shifts from the investor to the government (Vernon, 1971). Governments therefore offer significant advantages during the exploration and development phases, but can decide to take these advantages away during the extraction phase. The temptation to reduce the advantages given to a company is all the greater where the investment proves to be profitable, which is especially true during periods of high international prices (e.g. Zambia, Venezuela and Ecuador in 2008). This risk of time inconsistency in tax policy is due the government's fundamental difficulty in identifying the optimal tax system in an uncertain environment.

Therefore, aside from the neutrality of taxation, other political, practical and administrative considerations inform the choice of instruments used to tax the mining sector (Daniel *et al*., 2010; Otto *et al*., 2006; Lund, 2009; Baunsgaard, 2001; Land, 2008). Whether to make tax revenue secure, reduce the risks borne by the government or the investor or facilitate tax administration, a large number of instruments are implemented in countries and help to determine the share of mineral resource rent that goes to the government (Appendix 2). Certain taxes are specific to mining activity, and others are common to all formal companies within the economy even though their tax base or rate may differ from those under the common law system (Charlet *et al*., 2013). Non-tax instruments supplement taxation in the capturing of mineral resource rent: royalties, production sharing, acquisition by the government of free equity, contributions to expenditure on local infrastructure, and so on. In the Democratic Republic of the Congo, the government owns 5% of the capital of all mining companies that operate in the country and has proposed increasing its stake to 35%; in Burkina Faso, this stake is 10%, and in Mongolia, the government has acquired 34% of the capital in the OyuTolgoi project. This situation means that the government is both a regulator of the sector and a shareholder of mining

[7] Opportunistic behaviour on the part of governments which can be tempted to increase the tax burden once investments have been made.

companies at the same time (Allaire *et al*., 2013). Every resource rent sharing instrument has a greater or lesser impact on the exploitation of the resource.

According to the classification of Otto *et al*. (2006), *in rem* taxes (or 'production-based taxes') directly increase production costs (unit-based royalties, *ad valorem* or specific royalties, sales taxes, which affect the variable costs of the project; import and export duties, value added tax, withholdings tax on loan interest and services, registration fees and property taxes, which affect fixed costs) and thereby generate economic distortions which change investment and production decisions (Guj, 2012). *In personam* taxes (or 'profit-based taxes') are based on net revenue (taxes on profits, additional profits taxes, withholding taxes on remitted dividends, royalty based on some measure of profit, amongst others) and are therefore closer to a tax on rent. But the use of *in personam* taxes alone only allows for inadequate sharing of rent due to the sensitivity of their base to transfer prices and the more or less aggressive tax optimisation strategies of private investors (Radon, 2007). To the criterion of neutrality, Baunsgaard (2001) adds the criteria of risk-sharing and ease of tax administration. *In rem* taxes limit the risk for the government by making revenues secure from the beginning of the project and are simple to administer.

Identifying the tax system which allows a 'fair' share of rent seems to depend on degree of the risk aversion of the government and private investors and on the government's administrative capacity to collect the tax. Considering this, the optimal share of rent would therefore vary from one government to the next (and even to one ministry to the next: ministry of finance versus ministry of mines, petroleum and hydrocarbons). Given that a system needs to be stable in order to attract companies, a tax system that makes it possible to reconcile the expectations of all stakeholders is critical during negotiations.

The increase in the number of resource rent sharing goals has accelerated since the 1990s. Expectations with regard to mining sector taxation go beyond mere revenue-raising and extend to the environment (Sinkala, 2009; Collier and Venables, 2014), the impact of the sector on the local labour market (Public Expenditure Plan, 2014) or economic development in its broadest sense (Bird, 2014). Inter-temporal management of public funds levied from the mining sector also features prominently in the literature (Baunsgaard, 2012; Traoré, 2014). The aim is no longer to tax rent as much as possible in order to maximise public funds without altering the production chain, but to maximise social wellbeing. The tax system framework is thus moving away from the pursuit of economic neutrality and demonstrates the importance that is attached to each objective by mining governments. Every system has consequences for project life and hence the sharing of rent between governments and investors (Cawood, 1999; Cordes, 1995; Otto *et al*., 2006). The increase in the number of mining taxation objectives is giving rise to a complex web of taxes, making it difficult to assess the sharing of rent and its economic impacts.

3. Empirical approaches: resource rent sharing and available sources of information

The sharing of mineral resource rent between governments and investors is often criticised for being unfavourable to African governments. However, few studies put figures on this phenomenon. After a description of the two dominant methods of valuing rent, the main indicators used to assess tax systems are presented. Shafiee *et al*. (2009) propose a literature review of empirical studies that use these two methods, but do not address resource rent sharing. Smith (2013) proposes a review of literature focusing on the sharing of mineral resource rent and highlights the importance of modelling choices on the result.

3.1. Calculating rent: the discounted cash flow method and the modern asset pricing model

The net present value (NPV) that should be generated during the lifetime of a project depends on annual mineral output, exploration and development costs, capital costs and extraction costs, the lifetime of the project, the sale price, and the discount rate that is associated with the project and incorporates the risk (Guj and Garzon, 2007). Two main methods are used to determine NPV: the discounted cash flow (DCF) method and the modern asset pricing (MAP) model.

Discounted cash flow (DCF) method. If a project is 'certain' and without risks, the discount rate is the opportunity cost of the capital. If cash flow is uncertain and risky, the discount rate is made up of the opportunity cost of the capital and the premium that compensates the risk assumed by the investor. This risk may be project-specific and/or country-specific. Most models incorporate a single cash flow but allow for sensitivity analyses that consider different cost or price profiles. Monte Carlo simulations are often performed in order to determine a probability distribution for each uncertain project variable and thereby obtain different cash flows (Bohren and Schilbred, 1994). Even at the lowest anticipated price, a mining project should be able to break even (Crowson, 1998). The following are needed to create a DCF model: (i) forecasts for the price of the mineral over the entire duration of the project, (ii) a valuation of costs making it possible to calculate the revenue from the project, and (iii) the discount rate of the project after tax.

Several authors underline the limitations of this method (Bradley, 1998; Daniel *et al*., 2010; Mackie-Mason, 1990; Samis *et al*. 2007; Smith, 2013; Salahor, 1998). On the one hand, it requires perfect knowledge of the economic indicators that are involved in calculating NPV, and on the other hand, it entails knowing the risk associated with each stage of the project. If this is not the case, the modeller most often assumes uniform risk, which is not necessarily realistic for long-term projects whose risk decreases over time. Finally, these models are arithmetical and non-behavioural, which limits the scope of the results and assumes that taxation is neutral in respect of production and investment decisions (Smith, 2013). Finally, the model does not take account of managerial risk, i.e. the possibility that the mine may be abandoned before the end of its life cycle, or that work may be suspended temporarily (Smith and McCardle, 1998).

Modern asset pricing (MAP) model. In order to take different risk profiles into account, an alternative to the DCF model is to calculate the certainty equivalent. Brennan and Schwartz (1985) were the first to use this method to value natural resource exploitation projects (Grinblatt and Titman, 2002; Laughton, 1998). This method involves determining the cash flow that the investor is willing to receive without risk and comparing it with expected future cash flows. The investor does not mind whether he receives this certainty equivalent or the uncertain future cash flow. The net present value of the project is then defined as the sum total of certainty equivalent flows discounted at the risk-free rate. The modern asset pricing (MAP)[8] model is an elementary form of the 'real option value'[9] model which takes into account, within a stochastic forecasting model, the price dynamics of the mineral and incorporates the interaction between the uncertainty as to price and the risk in terms of the project's value. Several price change models exist, according to the type of mineral that is studied (Salahor, 1998; Baker *et al*., 1998). In 1996,

[8] Modern asset pricing (MAP) model.

[9] By comparison with the real option value model, only managerial flexibility, i.e. the possibility that the mine will be abandoned before it reaches the end of its life cycle or that activity will temporarily be suspended, is not taken into account (Podda Abouna, 2014).

Laughton used the MAP method to assess the financial structure of a mining project. According to Moel and Tufano (2002), companies are increasingly using the MAP method to make their own forecasts. To create this type of model, it is necessary to:[10] (i) choose the stochastic price change forecasting model, (ii) determine the price risk due to uncertainty regarding the price of the mineral over the period and its discount rate,[11] and (iii) build the cash flow model for the project whilst taking account of the prices predicted by the forecasting model and information concerning the costs of the project. The main difficulty of the MAP method lies in identifying the right risk profile. Most of the time, only the price is regarded as uncertain and the costs of the project are considered to be known. It is therefore necessary to obtain information concerning forecasts for the prices of commodities on the financial market.[12] Bradley (1998) shows that valuing net revenues using the DCF method or the MAP method gives different results and generates revenue flows with different profiles.

These two methods have advantages and disadvantages. However, in both cases, having access to economic information concerning the project and testing different risk profiles are the two crucial points in calculating rent. Only after evaluating the NPV for each project developed in the country is it possible to measure the sharing of rent between governments and investors. It also measures its effects on investment decisions by way of a certain number of indicators.

3.2. Rent sharing indicators

Several indicators are used in the literature to assess tax systems in the mining sector (Daniel and Goldworthy, 2010; Otto *et al*., 2006; Keen and Boadway, 2009; IMF, 2012). Only the ones that are most widely used in empirical studies are presented here (see Table 1). The investor is interested in profitability indicators, whereas the government seeks to measure its share of rent.

The indicators chosen by companies measure the profitability of their investment over the entire duration of a project. The investor's share of the rent corresponds to the discounted value of net cash flows after tax. The profitability of the investment is valued by the internal rate of return on the investment (IRR), which corresponds to the discounted rate for which the sum total of cash flows is nil. In principle, investment only occurs if the opportunity cost of the capital is lower than the internal rate of return on the project. The marginal effective tax rate (METR), for which a proxy can be calculated from the IRR before and after tax, captures the impact of the tax system on the decision to invest. For a given level of project profitability required by the investor, it measures the additional profitability that the project must yield in order to cover tax liabilities. It may be regarded as an indicator of tax system neutrality. According to Brealey and Myers (2005), the IRR calculation method does not make it possible to take account of variability of the opportunity cost of capital over time and makes it difficult to compare projects with each other. Empirical studies often compare, for the same project, the impact of different tax systems on the sharing of rent from a single project.

The indicator that is most commonly used to measure the share of rent captured by the government is the average effective tax rate (AETR). AETR is the ratio of the NPV of government revenue and the NPV of project pre-tax net cash flows13. All taxes specific to the

[10] Guj and Garzon (2007), quoted in Podda Abouna (2014).

[11] The discount rate is the risk-free interest rate, because risk is already taken into account in the stochastic model.

[12] Depending on the mineral, the London Metal Exchange, KITCO or the New York Mercantile Exchange websites.

[13] Several calculation methods are used in the literature (Otto *et al*., 2000; Devereux and Griffith, 2003).

sector, such as those under the General Taxation Code and other charges and fees, must be considered. The AETR makes possible to assess the distribution of the tax burden between companies in order to assess fairness in the treatment of companies (Fullerton, 1984; Johnston, 2003) and make international comparisons (Daniel et al., 2010; Charlet et al., 2013). The share of government revenue in total project benefits, measured by the ratio of tax revenues paid by the investor and discounted net cash flows less the initial investment, makes it possible to assess the sensitivity of government revenue to variation in prices and/or costs and hence how progressive the tax system is14. A progressive tax system can encourage the government to develop the sector, but a regressive system can enable the government to guarantee a minimum level of tax revenue (Brewer et al., 1989). Calculating the coefficient of variation in the proportion of rent received by the government for a given revenue distribution makes it possible to ascertain the possible variation in government revenues, i.e. the risk assumed by the government.

Table 1: Main indicators selected in empirical literature

Agent	Objective	Indicator
Investor	Neutrality	Marginal effective tax rate (METR) Breakeven price
	Profitability	Internal rate of return on the project (IRR) Payback period
	Identification of risks	Coefficient of variation of Net Present Value and IRR
Government	Tax revenue	Average effective tax rate (AETR) Expected government revenue
	Identification of risks	Time profile of government revenue Coefficient of variation in expected tax revenue

3.3. Review of empirical studies

Few empirical studies quantify the sharing of rent between investors and governments in the natural resources sector (see Appendix 3). Oil is the sector that has been studied the most (Black and Roberts, 2006; Daniel *et al*., 2008; Tordo, 2007), followed by gold (Brewer et al., 1989; Otto *et al*., 2006; *inter alia*). In the great majority of cases, studies are carried out on hypothetical mining projects and the authors apply different tax systems to the project (Black and Roberts, 2006; Brewer *et al*., 1989) or only change the base for one tax in order to determine the impact on investment indicators or the capturing of rent by the government. Special attention has been paid to different types of royalties (Otto *et al*., 2006; Daniel *et al*., 2010). It is rare for simulations to analyse the overall framework of a mining tax system for a single country. Charges and fees are often dealt with secondarily to tax instruments (Black and Roberts, 2006), which makes the calculation of resource rent sharing incomplete. The aforementioned indicators are commonly used by the authors to combine the operation of a tax with an objective of neutrality of taxation or government revenue. The discounted cash flow method combined with *ad hoc* sensitivity analyses is the commonest method. Few studies take into account the effects of interaction between the mining sector and the rest of the economy (Thomas, 2001). Finally, it is important to note that there has been very little analysis of the tax systems in developing

[14] This particular indicator still under revision in FAD.

countries, more specifically, in African countries. All of these studies are listed in Appendix 4 to this document.

The IMF made efforts to improve the knowledge of states in the rent-sharing area. The FARI model is now used in countries receiving IMF technical assistance in the mining and oil sectors. However, neither the basic economic data nor the tax information or the results of rent sharing studies are publicly available for at least two reasons: (1) technical assistance reports are compiled from confidential data; (2) they are property of the local ministry of finance of countries receiving technical assistance and may be published only with their agreement. Furthermore, some natural resource rich African countries do not have specific technical assistance.

This literature review shows that it is currently very difficult to ascertain the actual sharing of rent between African governments and investors in a standardised manner. Economic data on projects are either not widely available or difficult for researchers to use, which forces them to create hypothetical mine projects. However, as Otto *et al*. (2006) and all of the sensitivity analyses in this literature point out, tax system evaluation indicators are sensitive to the characteristics of mines and changes in their economic environments. In addition, no maps are available, making regional or international comparisons difficult. In the current context of renegotiating mining codes, creating an innovative database that allows standardised assessment of the sharing of mineral resource rent in Africa would appear, in the light of the studies analysed, to be very important.

3.4. Problems faced by empirical studies: lack of economic and tax data

Ascertaining how rent is shared between governments and investors requires the capacity to calculate the net present value (NPV) that should be generated for each project. Whichever method is used, the following must be known: the annual production of the mineral, the capital costs and operating costs for each stage of the project, its lifetime, the sale price and the associated discount rate. The fact that few empirical studies have been carried out on mining projects clearly illustrates the difficulty of obtaining and processing this information. Economic data on industrial mining companies (feasibility studies, financial statements and technical reports) are available online for companies listed on stock exchanges in Canada, the USA, Australia and the United Kingdom. Data in feasibility studies (forecasts) can be compared with information held in activity reports (implementation). It may therefore be difficult, but not impossible, to create the economic part of the database.

To measure the sharing of NPV between investors and the government, it is also necessary to know all of the tax instrument and other charges and fees burden by the sector. None of the existing economic databases contains all these information on the mining sector. The FERDI database presents the tax revenues levied from the sector for 41 countries in sub-Saharan Africa over the 1980-2010 period (Mansour, 2014). The countries listed in the database make up over 95% of the countries that the World Bank publication describes as being natural resource-rich. Revenues from oil and gas and those from mining activities are combined, but few countries are rich in both hydrocarbons and minerals other than hydrocarbons. Revenues collected from activities in the mining, oil and gas sectors are separated from those collected from other activities. The ‘taxes on non-renewable natural resources’ category combines the tax revenues levied from extractive industries (corporation tax, royalties and also profit-sharing, dividends received on equity held in state-owned enterprises and dividends and other investment income received on holdings acquired directly by the government in extractive industries). The ICTD database lists the revenues levied from the natural resources sector and breaks them down by type of tax: income taxes, corporation taxes, indirect taxes (mainly export taxes) and non-tax

revenues. These two databases propose a sector-based approach which limits the opportunity to ascertain the sharing of rent between governments and investors for a mineral, much less analyse its determining factors. The Extractive Industries Transparency Initiative (EITI) promotes accountable management of natural resources by making public, the revenue paid by firms in each partner's countries. The database is broken down by country and by sector (oil/gas and mining). However, the EITI objective in not the rent sharing evaluation and do not allow to reach it.

To measure the sharing of rent, it is necessary to list the tax codes, mining codes, customs codes and mining agreements that are in force in Africa. Charlet et al. (2013) list the taxes levied in French-speaking African countries (see Appendix 2), which would make it possible to recalculate the revenues collected from each project and hence the sharing of rent.

Based on these tax information and project economic data, the expected rent sharing between governments and investors can be calculated for each mining project. It could be possible to compare the theoretical tax revenue with the effective tax revenue in the EITI database. The gap between expected revenue and achievement can be explained by a change in operating conditions (geology, costs and resource prices), failure of tax administration or tax optimization practices of mining companies.

4. Conclusion

The aim of this study is to review the theoretical and empirical studies concerning the sharing of rent in developing countries in order to identify the difficulties encountered in conducting this type of exercise, so that tools to mitigate them can subsequently be proposed.

Having reviewed the theoretical approaches to the valuation of rent on a microeconomic level, we find that mineral resource rent is a concept that is difficult to understand and measure; rent can change as a project moves from one phase to the next, and risk and the discount rate of the resource must be taken into account. The most widely accepted definition of rent relates to the calculation of the net present value of a project, i.e. 'the excess of revenues over all costs of production, including those of discovery and development, as well as the normal return to capital' (IMF, 2012). However, only if governments have the capacity to value the economic rent of a project can the possibility of capturing tax revenue in an economically neutral way be guaranteed.

Due to the difficulties in obtaining all of the information necessary to calculate mineral resource rent, governments are increasing the number of tax instrument, charges and fees in order to capture a share of resource rent that they deem 'fair' but which ultimately depends strictly on the objectives that they have set for themselves. This is why different indicators are used in the literature to assess tax systems in the natural resources sector according to the objectives of governments and investors. A review of empirical studies shows that few studies are conducted in developing countries and African countries in particular, and that they are based mainly on hypothetical projects. Knowledge of the actual distribution of rent between investors and governments is scant, and knowledge of its determining factors is even more so.

The distribution of mineral resource rent in Africa cannot be analysed without access to figures and transparent, standardised information. The creation of a rent-sharing database will be to conduct in-depth research into the value of the sector's tax potential, the tax optimisation practices of multinationals and the knock-on effects that the mining sector has on the rest of the economy, which cannot be possible considering the actual knowledge of rent sharing in Africa.

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Appendix 1: Renegotiation of contracts in Africa (as at 30 September 2013)

Country	Company	Mineral	Year	Status	No. of contracts	Contract	Effects of renegotiation
Democratic Republic of the Congo	Générale des Carrières et des Mines (Gécamines)	Copper, cobalt, zinc, nickel, uranium	2008	Renegotiated	23	Anvil Mining Kulu Concentrate Kinsevere, AMCK Sprl BOSS MINING Sprl (Mukondo Mining and Savannah Mining) Compagnie Minière de Tondo, CMT Sprl Compagnie Minière du Sud Katanga, CMCK Sprl Congolaise des Mines et de Développement, COMIDE Sprl Compagnie Minière de Luisha, COMILU Sprl Compagnie Minière de Musonoi, COMMUS Sprl DRC Copper and Cobalt Project, DCP Sari Kamoto Copper Company, KCC Sari Kasonta Lupota Mines, KALUMINES Sprl KIMIN Sprl (ex lease Gécamines – SOMIKA Sprl) Kipushi Corporation, KICO Sari Minière de Kasombo, MIKAS Sprl Minière de Kalumbwe Myunga, MKM Sprl Mutanda ya Mukonkota Mining, MUMI Sprl PTM Sprl (CAYMAN) Ruashi Mining Sprl Shituru Mining Corporate, SMCO Sprl Société Minière de Kolwezi, SMK Sprl Société d'Exploitation de Kipoi, SEK Sprl Société Minière de Kabolela et de Kipese, SMKK Sprl Société de Traitement de Terril de Lubumbashi, STL/GTL Sprl SWANMINES Sprl	Financial effects: - Signature bonuss Based on the principle of calculating with reference to the Chinese model, the signature bonus has been set at 35 USD/tCu, or 1% of the volume of reserves for the other substances. A total of USD 307,283,040 has been released as follows: - Gécamines: USD 290,613,040 - Kisenge Manganèse: USD 9,000,000 - MIBA: mainly prospecting contracts - OKIMO: USD 4,500,000 - SAKIMA: USD 70,000 - SODIMICO: USD 3,100,000 The first tranche of the signature bonus amount expected for 2009 is USD 66,220,000. - Area fees Renegotiation has benefited the state treasury by releasing evaded area fees of approximately USD 5,206,000, mainly for the partnerships with BORGAKIM (OKIMO) to the amount of USD 5,100,000 and MMK (SODIMICO) to the amount of USD 106,000. - Royalties Renegotiation has made it possible to incorporate the principle of payment of royalties to state-owned enterprises when partnerships commence production.
				Renegotiated and terminated	3	Chabara Mining Congo Zinc and PZCE	
	Entreprise minière de Kisenge Manganèse (EMKM-Mn)	Manganese	2008	Renegotiated	1	ORAMA PROPERTIES Sprl	
				Renegotiated and terminated	1	SENTINELLES Sprl	
	La Société Minière de Bakwanga 'MIBA'	Diamonds	2008	Renegotiated	5	Minière du Kasaï, MIKAS Sprl Société Minière de la Lulua, SML Sprl Société Minière de Sankuru, SMDS Sprl Société Kasaïenne de Diamants, SKD Sprl Société Minière de Lubulanji, LUMI Sprl	
				Renegotiated and terminated	1	DGI Mining Sprl	
	OFFICE DES MINES D'OR DE KILO-MOTO (OKIMO / SOKIMO)	Gold	2008	Renegotiated	5	Assistance Technique et Financier, ATF Blue Rosé Sprl Borgakim Sprl Gorumbwa Sprl Kibali Gold Sprl	
				Renegotiated and terminated	3	AMANI Sprl RAMBI Sprl TANGOLD Sprl	
	Société aurifère du Kivu et du Maniema (SAKIMA)	Gold	2008	Renegotiated	3	GEMICO Sprl GMB Sprl DFSA Sprl	
				Renegotiated and terminated	3	CAR Sprl COCO Mining Sprl and SOL Sprl	
	Société de Développement Industriel et Minier du Congo (Sodimico)	Copper	2008	Renegotiated	2	MMK Sari Long Fei Sprl	
				Renegotiated and terminated	3	KGHM Sprl MUYAFA Sprl SOCOMIE Sprl	

Guinea	Rio Tinto	Iron	2011	Renegotiated	1	Simfer SA	Settlement Agreement: government-owned equity, granting of presidential decrees, taxation and royalty and infrastructure.
	BSG Resources	Iron	N/A	Intention to renegotiate			
	RUSAL	Bauxite	N/A	Intention to renegotiate		Friguia	
Liberia	ArcelorMittal	Iron	2005	Renegotiated	1		The Indian giant set the prices of the mineral itself. After a year of discussions, the group is now following market prices; the tax exemption that it received has now ended.
Sierra Leone	African Minerals	Iron	2011	Renegotiated	1	Tonkolili Iron	
	London Mining	Iron	2011	Renegotiated	1	Marampa	Replaces the clause in the London Mining contract concerning a ten-year tax break for the company which reduced its tax rate from 37.5% to 6%, increasing in stages to 30%. Sources: 'THE REVISED LONDON MINING AGREEMENT' http://www.christianaid.org.uk/Images/sierra-leone-mining-briefing.pdf
Ghana	South Africa's AngloGold Ashanti	Gold	N/A	Intention to renegotiate on the part of the government but not accepted by the company	N/A	n/a	In 2010, Ghana changed the mining royalty rate to a fixed rate of 5% from a variable rate of 3-6%. AngloGold Ashanti and Newmont of Greenwood have stability agreements set at 3%. The government wants to renegotiate the stability agreement.
	Newmont of Greenwood	Gold	N/A		N/A	n/a	
Central African Republic	AREVA	Uranium	2008	Renegotiated	1	Bakouma	In July 2007, Areva bought UraMin, a Canadian uranium extraction company which at that time owned the Bakouma concession. The CAR protested and demanded that Areva renegotiate the contract. In August 2008, Areva agreed to pay USD 40 million over five years, to develop the country's infrastructures and to employ 900 local workers at the peak of its activity. At the end of 2009, the CAR demanded nearly 2 billion CFA francs (USD 4 million) in taxes and royalties in relation to the transfer of UraMin.
	Axmin	Gold	2009/2010	Renegotiated	1	Bambari/Ouaka	Axmin requested an exploration permit in March 2009 but only received one in August 2010 after agreeing to pay a bonus of USD 11 million and delivering three 4x4 vehicles.

Source: Charlet, Laporte, Graziosi (2013).

Appendix 2: Examples of tax systems in French-speaking Africa

Country	*Legislation*	*Mining royalty (% of total turnover)*	*Government stake*	*Profit tax*	*Minimum lump-sum tax*	*Tax on income from transferable securities*
Burkina Faso	Law no. 031-2003/AN of 8 May 2003 Decree no. 2005-048/PRES of 3 February 2005 Decree no. 2005-682/PRES/PM/MCE/MFB of 30 December 2005	7% - diamonds and precious stones 4% - base metals and other mineral substances 3% - industrial gold and precious metals 3% - artisanally mined gold, and tax relief of 100 CFA francs per gram is granted before the rate is applied	10% free equity interest	Exemption during exploration phase Rate reduced by 10 percentage points during production phase	**0.5%** Exemption during exploration phase Exemption for 7 years during production phase	**12.5%** Exemption during exploration phase Rate halved during production phase (6.25%)
Cameroon	Law no. 2010/011 of 29 July 2010 Law no. 001-2001 of 16 April 2001 Decree no. 2002/648/PM of 26 March 2002	8% - Precious stones: (diamonds, emeralds, rubies, sapphires) 3% - Precious metals: (gold, platinum, etc.) 2.5% - Base metals and other mineral substances 2% - Geothermal deposits, source water, mineral and thermal mineral water	10% free equity interest + right to acquire an additional stake in cash up to a total limit that cannot exceed 20%	35% (+3.5% by way of Additional Municipal Taxes, making an effective rate of 38.5%) Exemption during exploration phase		15% + 1.5% by way of Additional Municipal Taxes, making an effective rate of 16.25% Exemption during exploration phase
DR Congo	Law no. 007/2002 of 11 July 2002 Decree no. 038/2003 of 26 March 2003 Inter-ministerial order no. 3154/CAB.MIN/MINES/01/2007 and no. 031/CAB.MIN/FINANCES/2007 of 09 August 2007	**0%** - widely-used building materials **0.5%** - iron and ferrous metals **1%** - industrial minerals **1%** - solid hydrocarbons and other substances not specified **2%** - non-ferrous metals **2.5%** - precious metals **4%** - precious stones	No	**35%**		**20%**
Côte d'Ivoire	Law no. 95-553 of 17 July 1995 Ordinance no. 96-600 of 9 August 1996 Decree no. 96-634 of 09 August	**3%** - for gold, diamonds, precious stones and metals **2.5% -** for base metals	10% free equity interest	**25%** (or 20% for companies whose turnover is less than 1 billion CFA francs and individual entrepreneurs		12% - General-law rate 18% - Profit distributions which are exempt from profit tax or have not been taxed at the general-law rate 10% - Dividends of companies listed on the stock exchange 2% - Income from bonds that are redeemable within at least 5 years

Appendix 3: Empirical studies on the sharing of rent

Authors	Minerals	Methods	Economic data	Tax system simulation	Sensitivity analysis	Indicators
Black and Roberts (2006)	Oil	MAP	Hypothetical project	**Simulation:** Comparison of national tax systems *Alberta:* Taxes and royalty *Papua New Guinea:* Resource rent tax *Sao Tome:* Joint Development Zone *Tanzania:* Production sharing and resource rent tax *Trinidad:* Production sharing only	Monte Carlo simulation	Net present value before tax Net present value after tax Tax distortion index
Brewer *et al.* (1989)	Gold	DCF	Hypothetical project	**Simulation**: Comparison of national tax systems *Canada, USA, Australia, Brazil, Chile, Indonesia, Papua New Guinea, Peru, South Africa, Zambia*	*Ad hoc* change: profitability of project, inflation, price cycle	Effective tax rate
Daniel *et al.* (2008)	Oil	DCF	Three hypothetical projects with different price and cost structures	**Initial situation:** Royalty with deduction of 65% of capital costs, *Mozambique*. **Simulation:** (i) deduction increased to 90% plus production sharing, (ii) Simulation of other international systems: *Nigeria, Angola, Eq. Guinea, Mauritania, Ghana, Madagascar, Mozambique, Namibia, Sierra Leone then Norway, UK, Colombia, Australia, East Timor, Peru.*	*Ad hoc* change: sale price and discount rate	Time profile of revenue Project pre-tax NPV Contractor NPV Payback period Government revenue AETR, Breakeven Price and METR Government Share of total benefits Coefficient ov variation of government revenue Post Tax IRR, coefficient of variation of IRR
Devereux and Griffith (2003)	Industry	DCF	Hypothetical project	**Simulation:** Harmonisation of nominal tax rates within the European Union: *UK, Germany, France*	No	Net present value before tax Net present value after tax Average effective tax rate Marginal effective tax rate
Lund (1992)	Oil	MAP	Hypothetical project	**Initial situation:** *Norway*: Royalty, income tax, corporate tax, special oil tax, witholding on dividends, capital tax on book value of assets. **Simulation:** Zero royalty, production allowance, 'uplift' allowance abandoned for specific costs, depreciation allowed from the date of investment, reduction in rate of tax on petroleum.	Monte Carlo simulation	Net present value
Otto *et al.* (2006)	Gold, Copper, Bauxite	DCF	Three hypothetical projects with different price and cost structures	**Initial situation:** national tax system, *Chile, South Africa* **Simulation:** Eight different bases for mining royalties.	*Ad hoc* change: operating costs, capital costs, sale price	Internal rate of return of the project Investor's share of rent Average effective tax rate (AETR) Government revenue
Podda Abouna (2014)	Gold	MAP	Existing project Canada	**Initial situation:** Profit-based royalty, *Canada* **Simulation:** *Ad valorem* royalty and super-profit taxes	Monte Carlo simulation	Internal rate of return of the project Average effective tax rate Coefficient of variation of government revenue Coefficient of variation of private-sector revenue
Samis *et al.* (2007)	Gold	MAP and DCF	Existing project British Columbia	**Initial situation:** *Mongolia:* entire tax system. **Simulation:** addition of a super-profit tax	Monte Carlo simulation	Net present value
Thomas (2010)	Gold	Optimal control	Hypothetical project	**Initial situation:** *Mali:* Royalty, income tax, taxes on dividends. **Simulation:** Reduction in the royalty rate from 6% to 3%.	No	Net present value

Appendix 4: Main industrial gold mining companies present in Africa

Company	Headquarters	Weblink	Country	Mining projects
Acacia Mining	UK	www.acaciamining.com	Burkina Faso	1 project
			Tanzania	5 projects
			Kenya	1 project
Algold Resources Ltd	Canada	algold.com	Burkina Faso	1 project
			Mauritania	2 projects
Amara Mining	UK	www.amaramining.com	Côte d'Ivoire	1 project
			Sierra Leone	1 project
			Burkina Faso	1 project
AngloGold Ashanti	South Africa	www.anglogoldashanti.com	DR Congo	1 project
			Ghana	2 projects
			Guinea	1 project
			Mali	3 projects
			Namibia	1 project
			Tanzania	1 project
			South Africa	5 projects
Asanko Gold	Canada	www.asanko.com	Ghana	1 project
Aureus Mining Inc	Canada	aureus-mining.com	Cameroon	1 project
			Liberia	1 project
Avnel Gold Mining	Switzerland	www.avnelgold.com	Mali	1 project
AXMIN Inc	Canada	axmininc.com	Central African Rep.	1 project
			Mali	1 project
			Senegal	1 project
DRDGold	South Africa	Drdgold.com	South Africa	1 project
Endeavour	Canada	www.endeavourmining.com	Burkina Faso	2 projects
			Ghana	1 project
			Côte d'Ivoire	1 project
			Mali	2 projects
Gold Fields Ltd	UK	www.goldfields.co.za	South Africa	1 project
			Ghana	2 projects
			Mali	1 project
Golden Star R. Ltd	Canada	www.gsr.com	Ghana	3 projects
Harmony Gold Mining	South Africa	www.harmony.co.za	South Africa	13 projects
Goldston	Australia	www.goldstonresources.com	Gabon	2 projects
			Ghana	2 projects
			Senegal	1 project
Iamgold	Canada	www.iamgold	Mali	3 projects
			Senegal	1 project
			Burkina Faso	1 project
Kinross Gold Corp	Canada	www.kinross.com	Ghana	1 project
			Mauritania	1 project
La Mancha	Canada	www.lamancha.ca	Côte d'Ivoire	1 project
			Sudan	1 project
Legend Gold Corp	Canada	www.legendgold.com	Mali	6 projects
			DR Congo	1 project
Lion Gold Corp	Australia	www.liongoldcorp.com	Ghana	1 project
Metallon Gold	UK	Metcorp.co.uk	Zimbabwe	7 projects
Mwana Africa PLC	UK	www.mwanaafrica.com	DR Congo	2 projects
Nevsun Resource Ltd	Canada	www.nevsun.com	Eritrea	1 project
Newcrest Mining Ltd	Australia	www.newcrest.com.au	Côte d'Ivoire	1 project
Newmont Mining Corp	USA	www.newmont.com	Ghana	2 projects
Nordgold	UK	www.nordgold.com	Guinea	2 projects
			Burkina Faso	2 projects
Nyota Minerals Ltd	Ethiopia	www.nyotaminerals.com	Ethiopia	1 project
Pan African Resources	UK	www.panafricanresources.com	South Africa	2 projects
Perseus Mining Ltd	Australia	perseusmining.com	Côte d'Ivoire	3 projects
Randgold Resources Ltd	Jersey	randgoldresources.com	DR Congo	1 project
			Côte d'Ivoire	1 project
			Mali	2 projects
			Senegal	1 project
Resolute Mining	Australia	www.resolute-ltd.com.au	Mali	1 project
			Tanzania	1 project
Sonatrach	Algeria	www.sonatrach.com	Algeria	1 project
SEMAFO Inc	Canada	www.semafo.com	Burkina Faso	1 project
Sibanye Gold	South Africa	www.sibanyegold.co.za	South Africa	4 projects
Stratex International plc	UK	www.stratexinternational.com	Senegal	2 projects
			Liberia	1 project
Sunridge Gold Corp	Canada	www.sunridgegold.com	Eritrea	1 project
Teranga Gold Corp	Canada	www.terangagold.com	Senegal	1 project

Source: Summary of authors according to company declarations available online. Access to economic databases on companies present in Africa will make it possible to make this list comprehensive.